PLANETARY POLARIZATION NEPHELOMETER

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We have completed a breadboard validation for a planetary polarization nephelometer, raising this instrument from just a concept through to TRL 4 using PIDD funding. We are currently seeking further PIDD funding to continue this instrument development up through to TRL 6, culminating in its demonstration on a stratospheric balloon as a proxy for a planetary flight mission through an exotic and relatively inhospitable atmosphere.

Our instrument is aimed at determining the characteristics of the aerosols that are present in essentially all planetary atmospheres. These aerosols are important to understand, not only to catalog the particles that are the visible faces of most planets, but also because they have significant impact on the climates and atmospheric dynamics of these planets, and the details of their makeup can help us to understand other questions about the planets, such as processes active on or below the surfaces. For Venus, the aerosols contain a significant fraction of the Sulfur compounds in the atmosphere. Our instrument is crucial for a full inventory of these compounds in Venus' atmosphere and further for understanding the processes that get them there from the surface. Our instrument would also help identify the unknown blue absorber in Venus' clouds that accounts for 25% of its powerful greenhouse. For Jupiter and the other giant planets, our instrument would definitively identify the aerosol layers that we see and the altitude levels at which winds are tracked. For Titan, we would be able to more fully understand the absorption and emission of radiation within this extended atmosphere; both processes have a large influence on the climate and dynamics of Titan's atmosphere.

The polarization nephelometer uses a novel approach to the illuminating beam to allow us to extract more information from the light scattered back from adjacent aerosols than is typical in predecessor nephelometers. In addition to measuring the intensity phase function of the light scattered off adjacent aerosols, our instrument also measures the polarization ratio phase function of the aerosols as well. The polarization ratio phase function adds significantly more information about the particle properties, removing ambiguities that intensity phase functions alone leave. We are able to extract this information from the scattered light through fast modulation of the polarization of the illuminating beam, combined with temporal analysis of the scattered light. To ruggedize the instrument for use on planetary descent probes in harsh planetary atmospheres, we use only solid state and temperature insensitive techniques to modulate the polarization of the illuminating beam. We also only expose optical fibers to the harsh environment outside of the spacecraft hull, holding all the electronics, lasers and detectors within the hull of the spacecraft where thermal protection is presumably much greater. We anticipate a flight version of our instrument would require about 6W of power, 1kg of mass and 0.7L of volume. It would be a good addition to any probe sent to a planet or satellite with an atmosphere, or even to the moon to analyze lofted moon dust.